

Systematic Review

Mixed shift rotations, sleep, burnout and well-being in professions similar to radiographers: A systematic review



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ABSTRACT

Introduction: Delivering 24 h healthcare requires rotational shift work from doctors and the medical imaging team, while contributing to safe and timely care of patients. Additional service pressure and staff shortfall leads to workload pressures, adjusted shift patterns and risk of burnout. Evidence should be sought to the effects of this work on staff.

Methods: This systematic review followed PRISMA reporting guidelines, using a convergent mixed methods approach according to Guidance from Joanna Briggs International. Quantitative trends and results were qualified in order to thematically analyse in conjunction with qualitative data and discussed together in context.

Following initial searching, returned articles were screened by title and abstract. A team of 3 reviewers undertook blinded critical appraisal of those suitable, with quality assurance from a 4th team member. Papers passing a threshold of 75% on JBI appraisal tools were accepted for synthesis. Data extraction of appropriate articles retrieved was undertaken in parallel.

Results: Following screening and critical appraisal, 13 studies were returned focusing exclusively on Non Consultant Doctors. No studies investigated diagnostic radiographers. 85% (n = 11) reported negative association between shift work and the three themes of sleep/fatigue, burnout and wellbeing: including after the introduction of shift pattern control or adjusted shift patterns. The remainder showed no change, or any improvement nullified by countermeasures to maintain service delivery.

Conclusion: Current working practices and shift plans in the target population showed detrimental effects on the participants – this can be suggested that Diagnostic Radiographers may suffer fatigue, burnout and poor mental health from stretched shift working patterns.

Implications for Practice: Further study into the effects of shift work on Diagnostic Radiographers and other allied health professionals is indicated – relating to the above themes in the context of errors and patient safety. Additional research into Non Consultant Doctors, shift work effects and the context of wider service delivery required; with suitable interventions and education to maximise understanding of legal working practices, monitoring and self-management of symptoms.

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Background

Professional practice in healthcare is rooted on the principle of safe care, and staff working in this sector are regulated to maintain this. This can prove to be demanding on both a physical and emotional level. Hospital departments such as the Emergency Department, Urgent Care and Radiology operate a highly process

driven environment^{1,2} to turn around a high influx of both urgent and planned referrals. This is additionally complex for radiographers maintaining safety with ionising radiation and strong magnetic fields^{3,4} – with risks of harm, including carcinoma,⁵ genotoxicity⁶ or contrast induced anaphylaxis.⁷ Radiology and urgent care facilities are central to patient diagnosis and monitoring⁸ and operate on a 24/7 basis,⁹ primarily through shift patterns to cover the day and night periods. While imaging referrals increase¹⁰ there remains a 10% national vacancy rate for radiographer posts,^{11,12} requiring additional workstreams and extended practice hours to meet demand. Existing staff cohorts are therefore subject to the additional expectation of managing the workload² through

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additional shift allocations and/or short notice switching between day and night work. The additional energy drain on staff, plus the “stress of conscience” when giving rushed or substandard service, puts patients at risk and can result in burnout¹³ as described in Fig. 1.¹⁴ The primary symptoms of burnout are exhaustion, disassociation from work and low mood.¹⁵ Repeated cycles of burnout exposure, particularly in healthcare, can lead to Shift work Disorder¹⁶: manifesting as insomnia, excessive sleepiness during the day, and increased risk of metabolic syndrome¹⁷ – hypertension, diabetes and weight gain. These feelings and symptoms increase the risk of communication or process errors due to inhibited performance.^{18,19} It also could impact on retention of staff.²⁰ These staff centred impacts of “work schedule tolerance” will reduce resource and increase pressure of demand on radiology services if unmanaged,¹⁹ leading to compromised care for patients in terms of timing and quality.

Wellbeing during shift work is an under-researched area in the diagnostic radiography population.¹⁹ Systematic reviews exist in nursing^{21,22} which report positive and negative effects. This gives some insight but has limited applicability due to the difference in professional working environments. Other healthcare staff such as non-consultant doctors have existing literature reviews but not radiographers. Other professional groups have similar shift culture and working environment changes (further expanded within the method) which would be similar to Non Consultant Doctors and radiographers. For the purposes of this systematic review, those groups were included as described in Table 1.

Methods

The aim of this systematic review was to explore the effects of shift working on sleep, fatigue, burnout and wellbeing. This Systematic Review follows Piper’s guidance for healthcare specific subjects²³ and using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) format.²⁴ The framework and process have been aligned to guidance from Joanna Briggs International²⁵ for mixed methods approach – allowing investigation of both qualitative and quantitative approaches to investigating demand (workload effects) and resource management (allocation and shifts and their consequences) on healthcare professionals across 24 h service delivery.²⁶ The findings and discussion use a convergent approach^{27,28} allowing quantitative themes to be merged with narrative from qualitative literature.²⁹ A mixed methods review is innovative but is still an ongoing development as to format and process. Convergent methods drew thematically from quantitative data to analyse the findings in parallel with the qualitative study present, using themes from De Hert’s burnout progression model.¹⁴

Management of records was undertaken using Endnote³⁰ and Rayyan,³¹ while the inclusion criteria were defined by Richardson’s PICO format.³²

Information sources

Medline, Embase, PsycINFO, AMED, Global Health, JBI EBP, Emcare, CINAHL plus, Web-Of-Science, Cochrane Reviews, PROSPERO

The selected databases included biomedical, sociology, psychology and clinical journal articles of both qualitative and quantitative nature, in English only. Conference papers, case studies, editorials and opinion pieces were excluded.

Inclusion criteria

Population: The Included healthcare professionals were identified as having similar shift patterns and variation of work setting from day to day, i.e., moving to different locations within the hospital or their directorate while working with a mix of acute and elective patients. This was reviewed with other educators in healthcare and agreed on.

Intervention: Included search terms reflected any work pattern beyond the standard office hours of 8am to 6pm as defined by the Working Time Regulations 1998.³³ This included changes to rostering or duty hour restrictions and the effects of these.

Comparison: The selected search terms grew around tolerance of the work schedule, using MESH terms to broaden available literature around care delivery, workload management and enablement of services 24 h a day.

Outcome: Search phrases were designed to reflect positive, neutral and negative effects as to observe outcomes of any nature and avoid reporting bias.³⁴

Previous studies

Searching PROSPERO, Cochrane Library, MEDLINE and Google Scholar returned no previous studies with the same selection criteria.

Data management, secondary searching & article selection

The initial retrieved articles were imported into Endnote.³⁰ After the removal of duplicates (n = 44) and non-English studies, the remainder were filtered by title and abstract by the lead researcher (JE). A further two were discounted due to full text only being available from the original author, as no response was received to contact via email and social media. A secondary search was undertaken using EBSCO, OVID and Google Scholar identifying any relevant studies from the citations within the suitable articles pre-critical appraisal.

The relevant articles remaining (n = 39) were uploaded into the Rayyan collaborative tool for blind critical appraisal.³¹ Secondary screening and critical appraisal was performed by the lead researcher and one of two independent reviewers (MB, CH) in

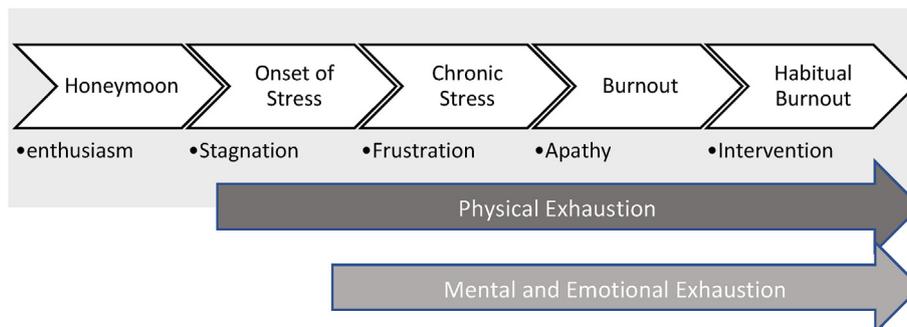


Figure 1. 5 stages of burnout (from De Hert; Burnout in Healthcare Workers: Prevalence, Impact and Preventative Strategies. Local Reg Anesth, 2020; 13; 171-83).

Table 1
Comparison of professions for consideration as review population groups.

Profession	Environments	Shifts	Pattern	Similar
Diagnostic Radiography	Multiple specialty or modality	Multiple types Overlapping	fast rotating from shift to shift	
Therapeutic Radiography	Multiple Therapy/Imaging/Preparation & Planning	Overlapping	Usually extended days bar emergencies	No
Nursing	Single	Multiple types	Blocks	No
Physiotherapy	Multiple	Minimal	Blocks/on call	No
Operating Department Practitioners	Multiple	Multiple	Varied	Yes
Cardiac Physiologists	Acute/non-acute	Shifts for acute work	Switching between fast and non-rotating	Yes
Non-consultant doctors	Specialty/Acute	Fast rotating	On call	Yes

blinded pairs, with the quality assurance of a postdoctoral researcher (RP) experienced in reviews. Suitable JBI appraisal tools²⁵ were used to screen and score the rigour of prospective articles; with post review discussion for discrepancies agreeing a score for those with differences (n = 2). This process is outlined in the PRISMA flow chart (Fig. 2).²⁴

Data extraction & transformation

Articles achieving a higher score than 75% using JBI critical appraisal methods were progressed to data extraction.²⁵ PICO criteria, study measures and tools used for collecting data were assessed, as well as location, outcomes and use of statistical

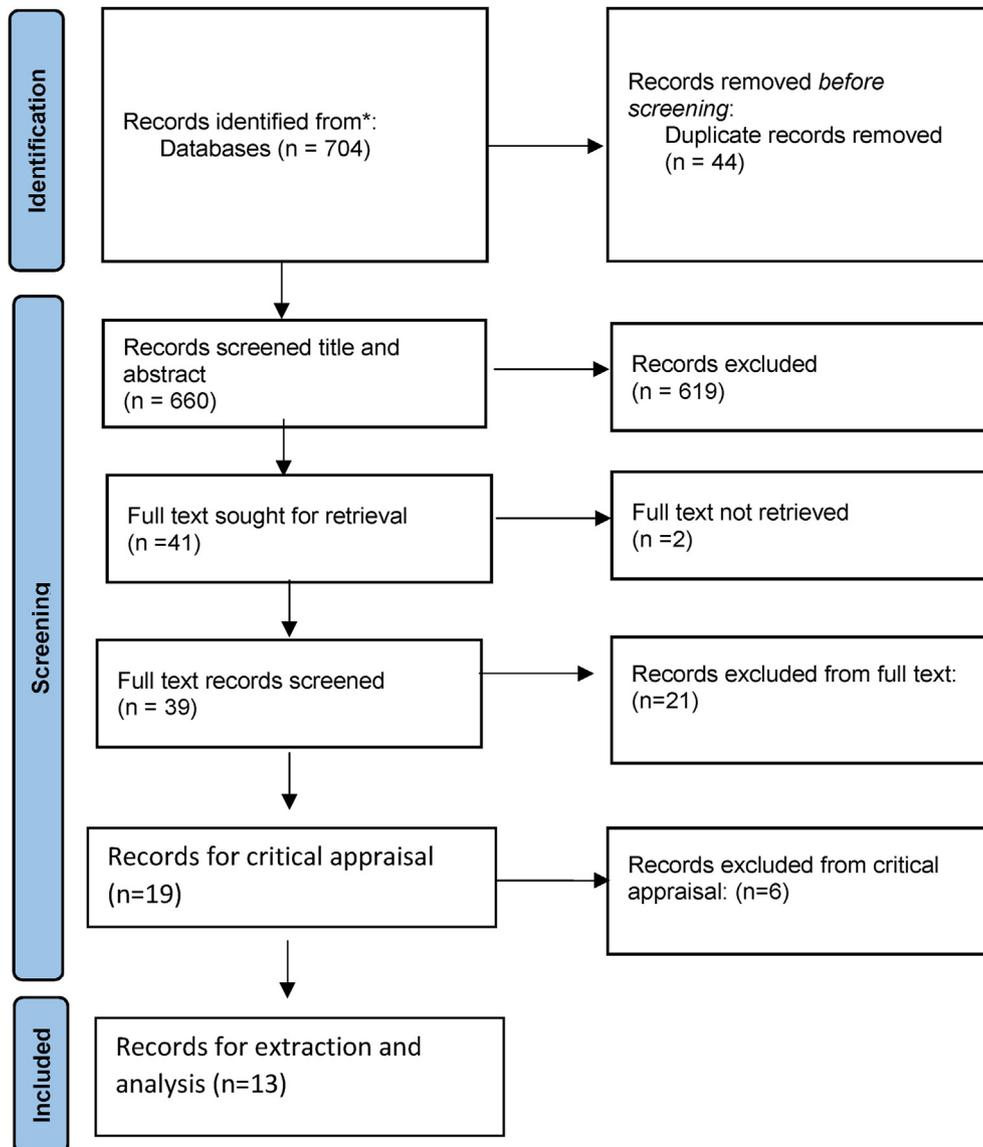


Figure 2. PRISMA reporting flowchart (Page et al.; The PRISMA Statement: an updated guidance for reporting Systematic Reviews. BMJ 2021; 372: n71).

analysis. This was done in parallel with the appraisal by the blinded pairs, in order to discuss synthesis and review. The lead researcher developed a narrative synthesis from this information, with guidance from PhD supervisors; transforming data ready for convergent analysis with the qualitative results, and to avoid the bias of context with other study results.

Findings & discussion

Initially, this systematic review intended to investigate the effects of sleep, fatigue, burnout and wellbeing on diagnostic radiographers. Few studies were available on the original criteria, demonstrating a recent problem or the profession being overlooked as a study group within healthcare. This justifies further research on diagnostic radiographers into the positive and negative effects of shiftwork but could also apply to Cardiac Physiologists and Operating Department Practitioners who are also without investigation.

Included study characteristics can be viewed in Table 2, with synthesis of findings collated in Table 3. All returned studies reviewed doctors.

Thirteen papers, 85% (n = 11) reported a detrimental effect on the participants with respect to exhaustion, burnout and detriment on personal wellbeing. Any study attempting to control shift patterns found that the positive effect on participants was counterbalanced by a decrease in another. The overall change was in some

studies negligible, due to a counteractive additional shift to ensure service delivery was maintained at existing standards.

Studies reported shift working in doctors was associated with poor sleep and exhaustion as previously found in other health care personnel.^{16,49–51} Interventions^{45,46} do not provide benefit, either through restriction or modification of hours. Some “sleep efficiency” was improved by models of restricted shifts⁴⁶ but this in turn rather reduced, wellbeing. When aligned with the qualitative data, this was represented by the fatigue burden described by participants in the focus group.⁴⁵ One radiography study indirectly suggests this may be already prevalent in the diagnostic radiographer population⁵² due to rapid changing of shifts.^{53,54} A full evaluation of rapid shift changing in UK radiographers would be beneficial.

Two studies (n = 2) reported increased burnout using the Maslach Burnout Inventory,⁵⁵ while others reported no effect on burnout but increased fatigue or decreased wellbeing. This is echoed in the qualitative focus group discussing lack of workload control when rotating through shift patterns, particularly the overnight on call system.⁴⁵ A particular concern was one study identifying 25% of participants working more than 80 h a week.⁴⁴ Evidence of burnout has already been identified in the radiographer population^{56,57} but not with respect to shiftwork practices. This may be due to the burden of additional working hours but requires further investigation.

The overall effect of wellbeing was mixed, half (n = 4) showing no change but negative effects in the other variables, while the

Table 2
Study characteristics.

Author	Year	Location	Design	Aims	P	I	C	O
Bolster & Rourke ³⁵	2015	USA	SLR	SLR of duty hour restriction effects on MRs	medical residents	shift hour restrictions	none	Sleepiness, wellbeing, wellness
Cavallo et al. ³⁶	2002	USA	ACS	effects of night float on med res	medical residents	Shift pattern change	Old pattern	effects
Elmariah et al. ³⁷	2016	USA	ACS	Burnout prevalence post AGCME rules	medical residents	post AGCME	Pre AGCME	burnout
Fabreau ³⁸	2013	CAN	QUA	effects of implementing a shift rotation bundle on wellbeing	medical residents	Shift pattern	none	wellness
Fischer et al. ³⁹	2015	DEU	COH	Effects of shift work measured in job demand/control, with prevalence of illness	medical residents	shift work	no shift	somatic complaints
Fletcher et al. ⁴⁰	2005	USA	SLR	Systematic review on duty hour restriction interventions	medical residents	shift hour restrictions	none	Hours, fatigue, sleep deprivation
Kalmbach et al. ⁴¹	2018	USA	ACS	effects of residency shift on sleep, activity and mood	medical residents	shiftwork	no shift	sleep, mood, physical activity
Levin et al. ⁴²	2019	CAN	QUA	interventional study - effects on wellbeing when switching shift patterns	medical residents	Shift pattern change	night shift	novel wellbeing score
Low et al. ⁴³	2018	SIN	COH	difference between on-call and night float in same cohort	medical residents	night float	on call	sleep, activity, fatigue
Mendelsohn et al. ⁴⁴	2019	CAN	COH	investigate activity, burnout, sleep in varying resident groups	medical residents	shift work	on call	sleep, activity, fatigue
Osamu et al. ⁴⁵	2016	JAP	MM	depressive symptoms post implementation of overnight shift	medical residents	shift	no shift	Depression, fatigue
Reed et al. ⁴⁶	2010	USA	SLR	SLR of duty hour restriction effects on MRs	medical residents	shift length & sleep time	pre-shift	health
Tucker et al. ⁴⁷	2010	UK	ACS	Investigate shift design issues that negatively impact on fatigue and wellbeing	medical residents	shift length & frequency	no shift	Wellbeing, fatigue

Location: CAN – Canada, DEU – Germany, JAP – Japan, SIN – Singapore.

Design: ACS – Analytical Cross Sectional, COH – Cohort Study, MM – Mixed Methods, QUA – Quasi Experimental, Systematic Literature Review.

Table 3
Study findings.

Author	Year	JBI SCORE	Design	Key findings	Sleep	Fatigue	Burnout	Wellbeing	Overall
Bolster & Rourke ³⁵	2015	72.70%	SLR	Duty hour restrictions have no benefit			negative	no change ^a	Negative
Cavallo et al. ³⁶	2002	75%	ACS	Review of cohort undertaking paediatric on call patterns	negative	negative	negative		Negative
Elmariah et al. ³⁷	2016	87.50%	ACS	Resident physician burnout rates working shifts		negative	no change		Negative
Fabreau ³⁸	2013	88.80%	QUA	Effects of amending duty hour rosters on medical interns				no change ^a	Negative
Fischer et al. ³⁹	2015	77.70%	COH	Physical symptoms do not vary in shift interventions where shift rotation remains complex		negative		negative ^c	Negative
Fletcher et al. ⁴⁰	2005	72.70%	SLR	Duty Hour Restrictions show no benefit due to additional workload generated	negative			no change ^a	Negative
Kalmbach et al. ⁴¹	2018	75%	ACS	Roster amendments in resident surgeons working shifts	negative			negative	Negative
Levin et al. ⁴²	2019	77.70%	QUA	Duty restrictions cause additional workload which undoes any effect				no change ^a	No Change
Low et al. ⁴³	2018	77.70%	COH	Effects of introduced additional shift to work pattern intensity		negative			Negative
Mendelsohn et al. ⁴⁴	2019	72.70%	COH	Effects on shiftworking residentsx	negative	negative	no change		Negative
Osamu et al. ⁴⁵	2016	100%	MM	Medical resident study into shift pattern effects		no change		negative	Negative
Reed et al. ⁴⁶	2010	72.70%	SLR	Duty limitations & protected sleep do not have overall positive change	positive ^b	no change		negative	Negative
Tucker et al. ⁴⁷	2010	87.50%	ACS			negative			Negative

^a Wellbeing improves with shift limitation but counteracted by decrease due to additional support shift.

^b Duty imitations alone, no additional shift.

^c Physical complaints as opposed to mental health/wellbeing.

others showed decrease in wellbeing. Confusingly a systematic review on duty hour restrictions⁴⁶ reported decreased wellbeing in 6 out of 11 studies. Three studies reported no change after intervention – all three showing positive effects before a countermeasure to manage service delivery which negated the improvements.^{38,40,42} In the focus groups, discussion was around the consequences of this posing communications issues between team members, pessimism and disassociation.⁴⁵ There is no wellbeing related comparator within diagnostic radiography research.

There were no randomised controlled or blinded trials within this review, so the grading of results according to JBI evidence levels²⁵ would be considered medium. While the research team used validated, assured methods⁴⁸ to interrogate and filter literature, no study scored exceptionally highly on critical appraisal.

Limitations

Only studies conducted in English were included in this review. While abstract review, critical appraisal and extraction were undertaken by the team due to limitations of time, the title screening was only undertaken by the lead researcher.

No studies included radiographers and therefore information is extrapolated from other health care professionals who worked shift patterns switching between work streams. While some similarities could be considered in nursing, the work patterns were not deemed suitably similar and therefore the profession was excluded from this review. Other existing nursing reviews^{21,22} can be reviewed for comparison, and identify similar issues, but cannot be considered fully similar to radiography, due to differences described in Table 1.

One of 13 studies was based in the United Kingdom, the remainder were international studies. The majority of these can be compared due to the similarity of shiftwork patterns across the globe when providing 24/7 emergency healthcare. Similarly, the duties of participants would be equivalent, the only potential difference being the balance of state to private-funded organisational framework.

Further study

The complexity of the radiographers role and recent changes to shift patterns warrants a specific study of the impact of working practices in this group, as well as ODP and Cardiac Physiologist population as they returned no studies.

This review confirms the negative effects of rotating shift work on fatigue, burnout and wellbeing among medical practitioners. There are no acknowledgement of workload levels that may be driving this fatigue bar discussions in Osamu et al.⁴⁶ and subjective measures in Fischer et al.³⁹ Further studies should review staffing levels and workload demand⁵⁸ to assess safe provision of service.

Clinical implications

The link between shift work, effects on the practitioner and the consequences on patient care have previously been identified.^{16,19,59} But not in the context of radiography. Firstly, research is warranted into 24 h healthcare delivery on health care professionals including non-consultant doctors (formerly junior doctors and encompassing the House Officer and Registrar groups). Following this, design of interventions to support systemic

management,⁶⁰ sleep scheduling⁶¹ and work scheduling⁶² should be tested – as opposed to previous shift bundle interventions which have shown no significant benefit.^{36,38,42,46}

Conclusion

This systematic review intended to investigate benefits and risks to fast-rotating shift work in professions similar to diagnostic radiographers. It returned evidence of negative physical and well-being impact of shift work and bundled out of hours work on non-consultant doctors, but not radiographers directly. More research is required on the original target population and in the context of their practice.

Conflict of interest statement

Principal author is a diagnostic radiographer. Principal author is a CORIPS Doctoral Fellowship awardee.

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Appendix 1. PICO Criteria

Population:

INCLUDED: Radiographers (Diagnostic AND therapeutic), Operating Department Practitioners, Cardiac Physiologists, Non-consultant doctors.

EXCLUDED: Other healthcare professionals.

Intervention:

INCLUDED: Shiftwork, night, out of hours, on-call, 12-h, shift pattern.

EXCLUDED: non-shiftwork studies.

Comparison:

INCLUDED: workload, service, delivery (work schedule tolerance).

EXCLUDED: Non work schedule related studies.

Outcome:

Positive: benefits, experience, acceptance, preceptor*, opportunit*, work life balance, recognition, fast-tracking, financial.

negative: burnout, fatigue, anger, sleep, inefficiency, absence, error proneness, anxiety, neutral: mood, motivation, wellbeing

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